Research in Developmental Disabilities 34 (2013) 4447–4454

Contents lists available at ScienceDirect

Research in Developmental Disabilities

The effectiveness of multimedia visual perceptual training groups for the preschool children with developmental delay

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ARTICLE INFO

Article history:
Received 7 August 2013
Received in revised form 11 September 2013
Accepted 11 September 2013
Available online 11 October 2013

Keywords:
Developmental delay
Group therapy
Multimedia
Visual perception

ABSTRACT

This study compared the effectiveness of three approaches to improving visual perception among preschool children 4–6 years old with developmental delays: multimedia visual perceptual group training, multimedia visual perceptual individual training, and paper visual perceptual group training. A control group received no special training. This study employed a pretest–posttest control group of true experimental design. A total of 64 children 4–6 years old with developmental delays were randomized into four groups: (1) multimedia visual perceptual group training (15 subjects); (2) multimedia visual perceptual individual training group (15 subjects); paper visual perceptual group training (19 subjects); and (4) a control group (15 subjects) with no visual perceptual training. Forty minute training sessions were conducted once a week for 14 weeks. *The Test of Visual Perception Skills*, third edition, was used to evaluate the effectiveness of the intervention. Paired-samples *t*-test showed significant differences pre- and post-test among the three groups, but no significant difference was found between the pre-test and post-test scores among the control group. ANOVA results showed significant differences in improvement levels among the four study groups. Scheffe *post hoc* test results showed significant differences between: group 1 and group 2; group 1 and group 3; group 1 and the control group; and group 2 and the control group. No significant differences were reported between group 2 and group 3, and group 3 and the control group. The results showed all three therapeutic programs produced significant differences between pretest and posttest scores. The training effect on the multimedia visual perceptual group program and the individual program was greater than the developmental effect Both the multimedia visual perceptual group training program and the multimedia visual perceptual individual training program produced significant effects on visual perception. The multimedia visual perceptual group training program was more effective for improving visual perception than was multimedia visual perceptual individual training program. The multimedia visual perceptual group training program was more effective than was the paper visual perceptual group training program.

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http://dx.doi.org/10.1016/j.ridd.2013.09.023

1. Introduction

1.1. Visual perception problems of children with developmental delays

Developmental delay is defined as significant delay in one or more of the following developmental domains: motor, language/communication, cognition, social/emotion, and activities of daily living for the children aged between 0 and 6 years old. The children are diagnosed as developmental delay (DD) when their clinical syndromes could not be determined as other specific developmental disabilities, such as mental retardation, autism, cerebral palsy.

The reported prevalence of developmental delay (DD) among children varies. Simeonsson and Sharp (1992) reported DD in 5–10% of children; a higher percentage, 13%, was reported by Rosenberg, Zhang and Robinson, 2008. Visual perception disorder is one of the common problems in children with DD (Case-Smith, 2009).

Problems with visual perception can interfere with the activities of daily living and learning of preschool children (Case-Smith, 2009; Kramer & Hinojosa, 2010). If visual perception is not fully developed by the time a child is in preschool, his or her ability to read (Flax, Mozlin, & Solan, 1984; Kulp & Schmidt, 1996a, 1996b; Solan & Ciner, 1989), to spell, to write, and to concentrate (Borsting, Rouse, & Chu, 2005) may be affected. In daily life, children with visual perception disorders may put their shoes on the wrong feet, put clothing on inside-out, and have problems tying their shoelaces (Schneck, 2005). They may have difficulty with cutting, coloring, drawing, working with building blocks, and putting together puzzle pieces or parts of toys. They may have also have problems doing their chores and homework (Borsting et al., 2003; Kulp, 1999).

Disorders in visual perception may also affect cognitive performance; for example, such children may have poor visual memory, often accompanied by poor recognition of objects, pictures and symbols, and poor memory of places and events (Todd, 1999). And, when they copy material, they must keep referring to the original document while transcribing, a tiring and inefficient method that makes them more prone to errors (Northway & Dutton, 2009). A deficiency of visual–spatial relationship may increase the chances of reversing letters, numbers, or words. Object permanence problems may lead to inefficient visual discrimination (Schneck, 2005). Hung, Fisher and Cermak (1987) proposed using a Test of Visual Perception Skills (TVPS) to measure visual perception; in their study, children with DD longer to complete a test and made more mistakes than did normal children. Hendee (1997) suggested that visual perception and cognition have mutual influences.

1.2. Approaches to visual perception problems

1.2.1. Multimedia visual-perceptual training

Visual perception can be improved with development, experience, practice, and therapy (Kramer & Hinojosa, 2010). Currently, clinical interventions of visual perception are divided into two major types: paper activity and multimedia activity. However, children are generally not motivated by paper activities, which also do not encourage a child to continue to participate in an activity. In contrast, computer multimedia provides interesting videos, sounds and lighting, colors and immediate feedback, which can promote the intrinsic motivation of children. Computer multimedia increases attention and continuity of activity participation, and leads to improved learning (Mayer & Gallini, 1990; Mayer & Sims, 1994; Paivio, 1991). When Mayer and Sims (1994) used computer multimedia as teaching materials, the authors found that integrating pictures and texts improved learning. Heimann, Nelson, Tjus, and Gillberg (1995) used an interactive multimedia program to increase the reading and communication abilities of children with autism, cerebral palsy, or mental retardation, and for normal children as well. As a result, the children had improved reading ability and language skills. Hutcherson, Langone, Ayres, and Clees (2004) used computer-aided teaching to teach 4 students with moderate-to-severe mental retardation to select items from a simulated store. Learning effectiveness and generalizability were then assessed. The study results showed that computer-aided teaching improved the students' accuracy of selecting items from the store. Poon, Li-Tsang, Weiss, and Rosenblum (2010) used computerized visual perception and visual-motor integration training program to train 13 normal schoolchildren (average age: 6.58 years). The training program lasted for 8 weeks. Poon found significant improvement in the students' writing ability, and the level of improvement was greater in the intervention group than in the control group. However, few studies have compared the effectiveness of multimedia training and traditional paper training for improving visual perception.

1.2.2. Group therapy

Currently, the most common training method for children with visual perception involves one-on-one individual training, and group training programs are relatively rare. However, group therapy has several positive functions: (1) mutual help and growth; (2) universality; understanding the universality of the problem and reducing feelings of loneliness and helplessness; (3) altruism: group members can gain self-esteem by giving and cultivate helping behavior; (4) information sharing: the group leader provides correct knowledge or group members provide advices and care; and (5) group cohesiveness: cohesiveness can facilitate self-disclosure and improve attendance. Further, acceptance and mutual support shared by group members help develop significant relationships; (6) participants have deeper self-understanding from the feedback of the group; (7) peer group discipline improves; and (8) participants gain from imitative behavior. An individual one-on-one program cannot provide all these benefits. Group therapy also has

economic and time-saving advantages over individual therapy, and more individuals can receive the service at the same time.

A search of the literature found no study comparing visual perceptual group therapy and individual therapy. Casey and Berman (1985), Weisz, Weiss and Langmeyer (1987) and Leblanc and Ritchie (2001) indicated no significant differences between results of group therapy and individual therapy. Children obtained similar benefits from group therapy and individual therapy (Bratton, Ray & Rhine, 2005). However, these studies were not primarily designed to investigate visual perception. Thus, we designed a study to compare the effectiveness of multimedia visual perceptual group training and individual training programs.

This study investigated the effectiveness of three treatment approaches: ''multimedia visual perceptual group training,'' ''multimedia visual perceptual individual training,'' and ''paper visual perceptual group training.'' This study hypothesized that children 4–6 years old with DD who receive multimedia visual perceptual group training would benefit significantly more than children receiving multimedia visual perceptual individual training, and that children receiving the individual training would do significantly better than children receiving ''paper visual perceptual group training.'' The study also hypothesized that the three training programs would be significantly more effective than control group.

2. Methods

2.1. Research design and setting

The study employed a pretest–posttest control group of true experimental to compare the effect of three visual perceptual interventions. Double blinded design was used to control the threats to scientific validity. Three occupational therapists conducted the testing. The pretest and posttest were performed by occupational therapist A. Occupational therapist B was responsible for data analysis, and was blinded to the subject assignment. Occupational therapist C was responsible for the visual perceptual training program. Children participating in the study did not know the purpose of the study, and because training programs were scheduled at different times. They did not know about the existence of the other training groups to avoid the effect of between-group competition. Children who met the recruitment criteria were randomized to one of three experimental groups (multimedia visual perceptual group training, multimedia visual perceptual individual training, paper visual perceptual group training) or to a control group.

2.2. Participants

The participants in this study were recruited from a group of patients receiving occupational therapy in the department of rehabilitation of a medical center in Taichung. The eligibility criteria were: (1) a confirmed diagnosis of DD by an attending physician from the department of rehabilitation or a certificate of DD issued by an attending physician from the child development center at the medical center; (2) age 4 to 6 years, and less than 7 years; (3) a total score on the TVPS-3 between 0 and −1 standard deviation, (4) parental consent for the child to participate in the study and a signed consent form from a parent of the child.

The exclusion criteria included: (1) a diagnosis of cranial nerve dysfunction or congenital chromosomal abnormalities, such as cerebral palsy, autism, attention deficit hyperactivity disorder, or Down's syndrome, for example; (2) a diagnosis of mental retardation; (3) sensory problems that could interfere with conduction of the TVPS-3 and participation in the visual perceptual program, such as visual or hearing impairment. Other contraindications included: (4) inability to complete the entire test, such as poor cooperation skills or poor comprehension; (5) missing more than 2 sessions (inclusive) during the program; and (6) inability to complete the second TVPS-3 test as scheduled (within 2 weeks after completing the training program.

This study initially recruited 90 children. The TVPS-3 total scores of 18 children did not meet the eligibility criteria (between 0 and −1 SD), and thus they were excluded. Seventy-two children (80.0%) met the eligibility criteria; 64 (71.11%) met the eligibility criteria of this study after the posttest; 8 children were excluded during the study period or posttest period. Five had missed more than 2 training sessions (inclusive) and 3 were unable to complete the posttest within 2 weeks after completion of the program.

2.3. Outcome measures

The Test of Visual Perception Skills (non-motor), Third Edition (TVPS-3) was re-established by Martin (2004). The TVS-3 is a standardized non-motor visual perception evaluation tool that tests the visual perceptual skills of children or adolescents; it is suitable for subjects of 4 years and 0 months old to 18 years and 11 months old.

The 112 TVC-3 questions cover visual perception, including visual discrimination, visual memory, spatial relationships, form constancy, sequential memory, visual figure-ground and visual closure. Questions gradually increase in difficulty. It takes about 30 min to complete the test. The total score of this test is the dependent variable of this study.

The scoring of each question is by ''0'' (fail) and ''1'' (pass). In each subtest, if 3 consecutive questions have a ''0'' score, the subtest will be stopped immediately and the total score calculated.

TVPS-3 has good internal consistency. The entire scale has Cronbach's $\alpha = 0.96$. It has a good split-half reliability. The whole scale has Spearman-Brown Coefficient = 0.96.

TVPS-3 also has good criterion-related validity. The criterion-related validity of the total of TVPS-3 and Visual-Motor Integration (VMI) is $r = 0.67$; it has moderate correlation. The total of TVPS-3 and the total of Motor-Free Visual Perception Test, Third Edition (MVPT-3) have significant correlation ($r = 0.79$, $P < 0.01$) (Ted et al., 2012).

2.4. Procedure

After the approval of the Ethics Committee of the hospital in the middle of Taiwan, then parents of each child gave written informed consent to participate and consent to publication of the results, we began to conduct pretest. In addition to occupational therapy scheduled once a week, children in the three experimental groups also received a 40-min visual perceptual training program once a week for 14 weeks. (The occupational therapy did not include any visual perceptual activity.) There were two classes of multimedia group training (7 and 8 subjects in each class). The training was scheduled from 5:30 pm to 6:10 pm and from 6:30 pm to 7:10 pm every Thursday night.

The paper group training had two classes as well (8 and 11 subjects in each class). The training was scheduled from 11:30 am to 12:10 pm every Wednesday morning and from 4:30 pm to 5:10 pm every Wednesday afternoon. Multimedia individual training was scheduled in the other free time slots either in morning or afternoon sessions. The control group received the originally scheduled occupational therapy only; however, the responsible therapist was asked to adjust the therapy to 40 min per session.

After excluding the subjects with poor attendance, the remaining subjects received the posttest within one week after the completion of the experimental program.

For ethical considerations, at the end of the study, children who had received multimedia visual perceptual training were scheduled for a 14-week paper visual perceptual training program. Children who had received the paper visual perceptual training program were scheduled for a 14-week multimedia visual perceptual training program at the end of the paper program. Children in the control group were scheduled for a 14-week multimedia visual perceptual training program, and a 14-week of paper visual perceptual training program after the posttest.

2.5. Visual perceptual training

The teaching materials used in the multimedia visual perceptual training program were prepared using Microsoft Office 2007 PowerPoint software. The program topic was visual perceptual ability, and it was divided into basic training and advanced training. The content was projected on a 152 cm (L) × 152 cm (W) screen. The distance from the projector screen to the nearest child was about 200 cm (78.74 in.). The basic training program mainly allowed children to practice, to memorize, to identify daily necessities and cartoon characters, and to learn spatial relationship of images. The advanced training program mainly had children to recognize, to discriminate, and to compare spatial relationship of geometries. The content of the multimedia visual perceptual group training program and the multimedia visual perceptual individual training program was the same; the only difference was one program was conducted in a group setting and the other program was conducted individually.

The content of the paper visual perceptual training program included color prints of the content of the Multimedia Visual Perceptual Training program created by the Microsoft Office 2007 PowerPoint software in A4 size (210 mm × 297 mm; 8.3 in. × 11.7 in.) "slides" in "printable items." The design of the paper training program was the same as that of the multimedia training program. The flow of programs for the three experimental groups was the same: in the first 10 min, the content was explained, a gaming atmosphere was created with the theme, and a sample program was demonstrated. During the next 25 min, the main program was conducted, allowing time for individual questions and answers. After answering all questions, the supervisor provided feedback and further teaching (further supplemental explanations). The last 5 min of the session was used for feedback.

2.6. Data analysis

The study used SPSS 13.0 (IBM Corporation, Armonk, NY) to test the differences between the results of the pretest and posttest visual perception with paired *t*-test. The ANOVA was used to test the differences in progress between the pretest and posttest of the four groups. Scheffe tests were used for multiple *Post hoc* comparisons. The *d* value was developed by Cohen to evaluate the effect size of intervention. The criterion for the level of statistical significance was at 0.05 in this study.

3. Results

3.1. Demographics of the study participants

This study recruited 64 children with developmental delay between the ages of 4 and 6 years, and included 53 boys (82.81%) and 11 girls (17.19%). Group 1 (multimedia visual perceptual group training program) included 15 subjects (14 boys, or 93.33%) and 1 girl (6.67%). Group 2 (multimedia visual perceptual individual training program) included 15 subjects

Table 1
Demographics of study participants.

	Group 1 ($n = 15$)	Group 2 ($n = 15$)	Group 3 ($n = 19$)	Group 4 ($n = 15$)
Sex				
Boys	14 (93.33%)	13 (86.67%)	13 (68.42%)	13 (86.67%)
Girls	1 (6.67%)	2 (13.33%)	6 (31.58%)	2 (13.33%)
Age (months)				
Pretest (M ± SD)	61.13 ± 7.57	59.47 ± 7.98	61.16 ± 7.51	65.93 ± 6.70
Range	48–72	48–73	50–77	54–75
TVPS-3				
Pretest (M ± SD)	26.93 ± 8.70	29.45 ± 6.47	27.11 ± 7.98	33.47 ± 10.40

Group1: multimedia visual perceptual group training, Group2: multimedia visual perceptual individual training, Group3: paper visual perceptual group training, Group 4: control group.

(13 boys, or 86.67%) and 2 girls (13.33%). Group 3 (paper visual perceptual group training program) included 19 subjects (13 boys, 68.42%) and 6 girls (31.58%). The control group included 15 subjects (13 boys, 86.67%) and 2 girls (13.33%) (Table 1). The sex of the four groups were tested by the chi-square test of homogeneity, $\chi^2 = 3.79$; $P = 0.29$ and did not achieve statistical significance.

The average age of the children in group 1 was 61.13 ± 7.57 months; the average age of the children in group 2 was 59.47 ± 7.98 months; the average age in group 3 was 61.16 ± 7.51 months; and the average age in group 4 (control group) was 65.93 ± 6.70 months (Table 1). The average age of the four groups was analyzed by one-way ANOVA, and the results showed that the *F*-value was 2.11; $P = 0.11$. The results showed that the average pretest age of the four groups had no statistical significance. The average pretest total raw score of TVPS-3 scale of group 1 was 26.93 ± 8.70; in group 2 this was 29.45 ± 6.47; in group 3, this was 27.11 ± 7.98; and in the control group the score was 33.47 ± 10.40. The average pretest total raw score of the four groups was analyzed by one-way ANOVA, and the results showed an *F*-value of 2.01; $P = 0.12$. Thus, there was no significant difference in the average pretest total score among the three study groups and the control group.

3.2. The effect of intervention in experimental groups

A paired-sample *t*-test was used to test the average pretest and posttest TVPS-3 raw score of the four groups. Significant differences were found in group 1 ($t = -9.23$; $P = 0.00$), group 2 ($t = -3.64$; $P = 0.00$), group 3 ($t = -4.18$; $P = 0.00$). There were no significant differences among the control group ($t = -1.20$; $P = 0.25$) (Table 2).

Cohen's *d* was used to calculate the effect size (Cohen's *d* = [(average posttest difference of TVPS-3 raw score of the experimental group − average pretest difference of TVPS-3 raw score of the experimental group)/standard deviation of pretest of the experimental group]). The calculated results suggested large effect sizes of the three experimental groups (group 1 was $d = 2.12$; group 2 was $d = 1.45$; group 3 was $d = 0.83$) (Table 2).

3.3. The comparison of improvements in visual perception in four groups

The differences of the average pretest and posttest TVPS-3 scores represent the visual perceptual improvement levels. This study used one-way ANOVA to compare the differences in the effectiveness between the four groups. ANOVA results were significant: $F = 12.89$, $P = 0.000$. The results indicated significant differences in the improvement levels among the four groups. Scheffe *post hoc* test results showed significant differences between: group 1 and group 2; group 1 and group 3; group 1 and the control group; and group 2 and the control group (Table 3). There were no significant differences between group 2 and group 3 or group 3 and the control group. Cohen's *d* was used to calculate the effect size (Cohen's *d* = [(average differences in pretest and posttest of the experimental group − average difference in pretest and posttest of the control group)/standard deviation of difference in pretest and posttest of the control group]). It showed that group 1 had the largest effect size with $d = 1.60$; group 2 had a moderate effect size with $d = 0.73$.

Table 2
Means, standard deviations, and paired *t*-test for effects of intervention in the visual perception.

Group	Pretest		Posttest		*t*	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Group 1	26.93	8.70	45.40	12.22	−9.23***	0.00	2.12
Group 2	29.47	6.47	38.87	9.82	−3.64***	0.00	1.45
Group 3	27.11	7.98	33.74	10.20	−4.18***	0.00	0.83
Group 4	33.47	10.49	35.13	9.61	−1.20	0.25	0.16

*** $P < 0.001$.
Group1: multimedia visual perceptual group training, Group2: multimedia visual perceptual individual training, Group3: paper visual perceptual group training, Group 4: control group.

Table 3
Comparison of TVPS-3progress in four groups.

	Pretest		Posttest		Differences (posttest–pretest)		*F*	Scheffe *post hoc* test
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*		
Group 1	26.93	8.70	45.40	12.22	18.47	7.74	12.89***	1 > 2, 1 > 3
Group 2	29.47	6.47	38.87	9.82	9.40	9.99		1 > 4, 2 > 4
Group 3	27.11	7.98	33.74	10.20	6.63	6.91		
Group 4	33.47	10.49	35.13	9.61	1.66	5.93		

*** $P < 0.001$.
Group1: multimedia visual perceptual group training, Group2: multimedia visual perceptual individual training, Group3: paper visual perceptual group training, Group 4: control group.

4. Discussion

After the visual perceptual training, children in the three experimental groups had significant differences in their total raw scores between the pretest and posttest TVPS-3. Among children in the control group, no significant differences were noted between the pretest and posttest scores. The three experimental groups had significant improvements, but were the differences between the pretest and posttest the result of "visual perceptual training" or "age-related development"? This study regarded the difference between the pretest and posttest scores of the control group comparing other three experimental groups as the result of "natural development." The difference of posttest minus pretest score represented visual perceptual improvement; this comparison showed that the improvement seen in group 1 and group 2 could exclude the developmental effect. Improvements seen in the two groups were significantly greater than were the improvements of the control group. The improvement noted in group 3 could not exclude the developmental effect. Therefore, it showed that the multimedia visual perceptual group training program and the multimedia visual perceptual individual training program significantly improved the children's visual perception. The multimedia visual perceptual group training program produced the greatest effect ($d = 1.6$). The multimedia visual perceptual individual training program had a moderate effect ($d = 0.73$). The paper visual perceptual group training program could not exclude the developmental effect.

The effectiveness of group 1 and group 2 training, which used multimedia, was significantly better than was the effectiveness reported in the control group. Previous studies suggested similar results. A study by Jacobs (1968) noted that visual perceptual skills can be taught in a structured program. In an 8-week controlled study, Poon et al. (2010) evaluated the effectiveness of a computerized visual perception and visual-motor integration training program. The results showed significant differences between the pretest and posttest MVPT-R (Motor-free Visual Perception Test – Revised) scores of the experimental group ($F = 8.58$; $P = 0.001$). The posttest MVPT-R scores between the experimental group and the control group also were statistically different ($F = 957.45$; $P < 0.001$).

In our study, in group 3, in which paper was used as the training media, the developmental effect could not be excluded. Possible explanations include the fact that paper visual perceptual games were one of the most commonly used training tools. This study could only avoid the control group obtaining the visual perceptual training materials used in the study; it was difficult to request that parents help their children avoid similar paper teaching materials. In addition, based on medical ethical considerations, it was not possible to request that the study children stop receiving the existing visual perceptual training in order to participate in the study. A number of paper game books recently written by occupational therapists are readily available in bookstores, and thus similar paper-based training materials could be easily obtained. Parents and teachers could easily conduct similar training at home or in child care settings or kindergartens.

From the angle of "different teaching materials," group 1 (multimedia) and group 3 (paper) sessions were both conducted in group settings, but there were significant differences between the two groups. The results indicated that the multimedia visual perceptual training program was significantly better than the paper visual perceptual training program. Many previous studies showed similar results and suggested that interactive nature as well as the sound and lighting effects provided by multimedia could draw a child's attention and induce learning. In addition to the static picture and text stimulations that were provided in paper teaching materials, multimedia teaching materials could provide animation and audio stimulation, allowing learners to obtain better learning results from these more diversified channels (Levin, Anglin & Carney, 1987; Mayer & Gallini, 1990; Mayer & Sims, 1994; Paivio, 1991; Park & Gittelman, 1992; Rieber & Kini, 1991). We also noted that features of computer multimedia used in the teaching process, for example, adding interesting sounds, colorful highlights, or animated feedback after a correct answer was given by the learner, could effectively draw attention and maintain the concentration of the learner.

Visser and Keller (1990) proposed three strategies for drawing learners' attention: sensory attraction, problem exploration, and maintenance by changes. The computer multimedia training program had "sensory attraction" (such as sounds and lighting effects) and "maintenance by changes" (such as animations and transitional scenes); the paper-based training program obviously lacked these two important factors. In addition, for "problem exploration," the computer multimedia interface allowed adding highlights or colorful frames to questions and keywords to draw a child's attention. With this, children could more easily to catch the points of the questions proposed by therapist during training program.

Also, since the multimedia program was projected on the wall, the objects presented were larger, which made it easier for the children to identify the detailed features of an object. The paper-based program lacked such features. When Claire and Gratt (1995) conducted a meta-analysis of 120 studies between 1966 and 1992, they found that 60% of learners taught with computer-aided multimedia did better than did learners taught with traditional methods. Thus, as the results of these numerous studies showed, and we found, a computer multimedia program was more effective than was a paper training program. To improve the motivation to learn, integrating a computer multimedia interface into teaching could generate positive learning results.

In the group multimedia program, teaching materials were projected onto a big screen; in contrast, the paper program used A4-size paper. One drawback to the large screen used in the group multimedia program was that it was prone to generate blind spots for children sitting at the two far sides of the room. These children often had to turn their heads to compensate for the blind spots. Adjusting their head positions and controlling their eye movements at the same time resulted in an additional burden.

Although group 1 (group program) and group 2 (individual program) both used multimedia, there were significant differences between the two groups. The multimedia group program was significantly better than the multimedia individual program. The two groups used the same teaching media and teaching methods. The individual program provided more chances for the participants to provide oral answers. Even though the group program allowed only one child to verbally answer a question in front of the class, the other children could observe the answering skills, and the therapist would guide the audience to answer questions by themselves. Regardless of the type of session, individual or group, the therapist provided relevant feedback at the end of each session. In multimedia group therapy, members might have benefited from observing other members and attempting new behaviors. The individual program lacked such features. The results of this study showed that multimedia visual perceptual group therapy was better than was individual therapy. Currently, the number of children who require treatment is increasing; in addition, parents often ask if treatment frequency can be increased. Multimedia visual perceptual group therapy may be the solution to the shortage of therapist and service hours.

Subjects in this study were randomized into three experimental groups and one control by random sampling. Group 1 included 15 subjects; group 2 had 15 subjects; group 3 had 19 subjects; and the control group had 15 subjects. Fraenkel, Wallen and Hyun (1993) have suggested that causal-comparative studies and experimental studies should recruit at least 30 idividuals for each group. However, if the experiment is properly designed and has rigorous experimental controls, 15 subjects in each group is acceptable. However, the study should be repeated to ensure that similar results can be obtained (Wallen & Fraenkel, 2013). This study had a true experimental design, which was a relatively stringent study design; thus, it met the above criteria. However, because the study recruited subjects from one hospital in one area, the results must be carefully extrapolated. There were more than 10 children in each study group, but only one therapist was present for training in each session. At the beginning of the program, when children had either little or no concept of the how the session would be conducted, it was difficult for the therapist to maintain order. If there is adequate manpower, we suggest to assigning an additional therapist to help maintain order in the class.

This study recruited the children who complied with the criterion of a total score on the TVPS-3 between 0 to -1 standard deviation in this research. Future studies should investigate the other extent of the difficulty on the effect of visual training program. The participants came from a medical center in Taichung, so we suggested that recruiting participants from multiple hospitals in multiple areas may help validate the result of this study. Results of this study showed significant benefits on visual perception of children with developmental delay, but whether it can be generalized or linked to the activities of daily living is still unknown. In the future, it might be helpful to conduct generalizability and social validity studies on the effects of visual perceptual training.

5. Conclusion

All three therapeutic programs produced significant differences between pretest and posttest scores. The paper visual perceptual group training program could not overcome developmental effects. Both the multimedia visual perceptual group training program and the multimedia visual perceptual individual training program produced significant effects on visual perception. The multimedia visual perceptual group training program was more effective for improving visual perception than was multimedia visual perceptual individual training program. The multimedia visual perceptual group training program was more effective than was the paper visual perceptual group training program.

Conflict of interest

The authors have no conflict of interest to declare.

Acknowledgements

The authors would like to thank National Science Council of Taiwan (Grant No. 101-2410-H-142-005-MY3) for supporting the editing service of manuscript.

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